William Lehman Injury Research Center

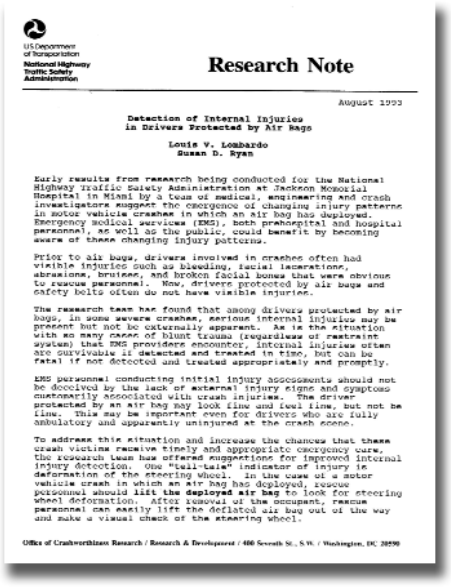
At the University of Miami School of Medicine

CIREN Program Report

Lifesaving through Better Recognition and Treatment of Crash Injury

This report illustrates the value of CIREN and the CIREN research process. Multi-disciplinary observational studies of serious injury crashes in CIREN generate insights into safety problems and potential solutions. Subsequent analyses can then advance scientific understanding of ways to improve the prevention and treatment of crash injuries.

Since its inception in 1991, researchers at the University of Miami's William Lehman Injury Research Center (WLIRC) have been conducting research on crashes, injuries, treatments, and outcomes. From the beginning of their work, researchers in Miami and at NHTSA recognized a need for better use of information from the crash to provide more effective emergency medical care to save lives and reduce disabilities.



U.S. Department of Transportation
National Highway Traffic Safety Administration

Research Note

August 1993

Detection of Internal Injuries in Drivers Protected by Air Bags

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Early results from research being conducted for the National Highway Traffic Safety Administration at Jackson Memorial Hospital in Miami by a team of medical, engineering and crash investigators suggest the emergence of changing injury patterns in motor vehicle crashes in which an air bag has deployed. Emergency medical services (EMS), both prehospital and hospital personnel, as well as the public, could benefit by becoming aware of these changing injury patterns.

Prior to air bags, drivers involved in crashes often had visible injuries such as bleeding, facial lacerations, abrasions, bruises, and broken facial bones that were obvious to rescue personnel. Now, drivers protected by air bags and safety belts often do not have visible injuries.

The research team has found that among drivers protected by air bags, in some severe crashes, serious internal injuries may be present but not be externally apparent. As is the situation with so many cases of blunt trauma (regardless of restraint system) that EMS providers encounter, internal injuries often are survivable if detected and treated in time, but can be fatal if not detected and treated appropriately and promptly.

EMS personnel conducting initial injury assessments should not be deceived by the lack of external injury signs and symptoms customarily associated with crash injuries. The driver protected by an air bag may look fine and feel fine, but not be fine. This may be important even for drivers who are fully ambulatory and apparently uninjured at the crash scene.

To address this situation and increase the chances that these crash victims receive timely and appropriate emergency care, the research team has offered suggestions for improved internal injury detection. One "tell-tale" indicator of injury is deformation of the steering wheel. In the case of a motor vehicle crash in which an air bag has deployed, rescue personnel should lift **the deployed air bag** to look for steering wheel deformation. After removal of the occupant, rescue personnel can easily lift the deflated air bag out of the way and make a visual check of the steering wheel.

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The first discovery was that while air bags protected the head and face in serious crashes, internal injuries could be missed. This happened because the previously common "tell tale" signs of bleeding from facial lacerations and broken facial bones were now not present to alert emergency medical care providers to the severity of the crash. In 1993, this discovery of a new injury pattern led NHTSA to issue a Research Note "Detection of Internal Injuries in Drivers Protected by Air Bags" to help emergency medical care providers better recognize occult internal injuries. The Research Note recommended that rescue workers "lift the deployed air bag to look for steering wheel deformation." [1] This "Lift and Look" tip to make a quick visual check was made to reduce the likelihood that potentially fatal internal injuries would be missed because motorists protected by air bags "may look fine and feel fine, but not be fine." Occult internal injuries from blunt trauma often are survivable if detected and treated appropriately in time.

In 1994, NHTSA published and widely distributed the poster "Look Beyond the Obvious" based on continued research at the Lehman Center [2]. This research found additional occult injury patterns that could be recognized using information from the crash. The "Look Beyond the Obvious" poster listed five indicators based on crash scene information to help emergency care providers detect internal injuries. These were organized into a checklist in an easy to remember mnemonic **SCENE**:

S – Steering wheel deformation? Look for a bent steering wheel.

C – Close proximity of the driver to the steering wheel?





For short and/or heavy drivers.

E – Energy of the crash? Twenty or more inches of vehicle crush.

N– Non-use of seat belts? Non-use of lap or lap/shoulder belts - look for internal injuries.

E – Eyewitness report of crash scene? Report crash severity indicators of occult injuries.

NHTSA continued efforts to use crash scene information to improve triage, transport, and treatment decision-making involving a team of researchers from several CIREN Centers. In 1996, NHTSA, under the direction of Dr. Ricardo Martinez, established a research project to improve the capability of identifying the characteristics of motor vehicle crashes that increase the risk of serious injury. The project was headed by Dr. Howard R. Champion, of the University of Maryland Medical School, and managed for NHTSA by Mr. Louis V. Lombardo [3-7].

URGENCY ACN software to Improve Triage, Transport and Treatment

This research resulted in the development of an algorithm to estimate the probability of the presence of serious injury in a car crash based on crash severity measures. In 1997, the NHTSA research team incorporated the algorithm into computer software named URGENCY 1.0 to relate crash severity measures to the probability of serious injuries. This software, URGENCY 1.0, was developed for use with Automatic Crash Notification (ACN) technologies to improve the rescue of seriously injured crash victims through faster and smarter emergency medical care decisions.

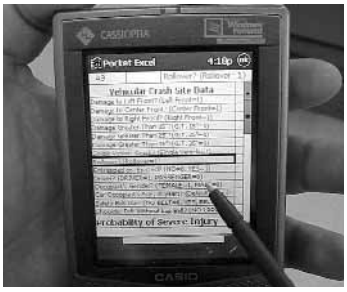
ACN with URGENCY software is designed to help the emergency medical care system distinguish, instantly and automatically, the approximately 250,000 vehicles in crashes with serious injuries that are both urgent and important from the 28 million vehicles in crashes each year that are mostly only property damage crashes.

URGENCY software uses vehicle crash sensor data in Automatic Crash Notification (ACN) systems to assist in instantly identifying crashes that are most likely to have time critical injuries. The URGENCY algorithm also provides the capability of improving injury identification, using data obtained from the scene. The prime purpose of the algorithm is to automatically provide emergency medical responders with objective information on crash severity to assist in detecting the approximately 1% of crashes with serious injuries needing the most urgent medical care. The algorithm calculates the risk of a MAIS 3+ injury being present in the crashed vehicle, instantly, and automatically at the time of the crash. The prediction can be subsequently updated as more information becomes available. The algorithm was based on multiple regression analyses using data from the National Accident Sampling System, Crashworthiness Data System, (NASS/CDS) years 1988-95.

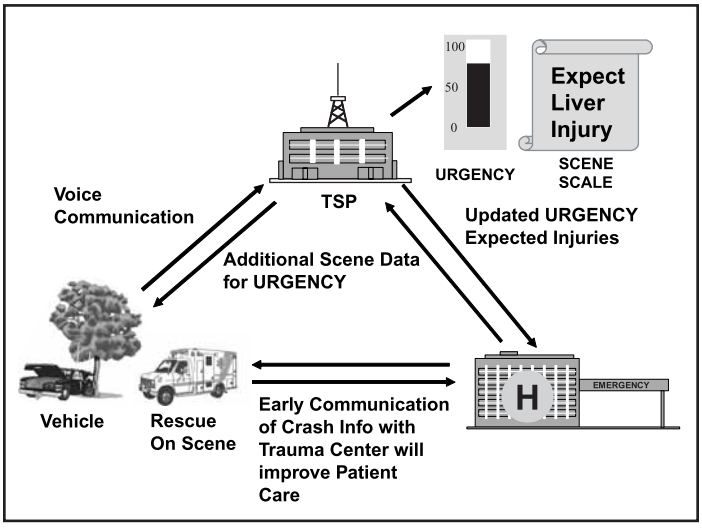
The accuracy of the URGENCY algorithm was first evaluated by applying it retrospectively to the population of injured occupants in the CIREN database at the Lehman Center [8].

URGENCY SCENE Software to Detect and Treat Occult Crash Injuries

In addition to developing improvements in URGENCY 1.0 for use with ACN, work has proceeded at the WLIRC to develop URGENCY SCENE 1.0 for use with handheld computers for use in all current crashes since most vehicle currently are not equipped with ACN systems.




The figure below illustrates how URGENCY information from the scene of a crash can be shared in the future to alert emergency medical care providers to improve treatment of crash victims using a pop-up Occult Injury Warning Flag “Expect Liver Injury”.



The CIREN Centers are in a unique position to test and evaluate both the ACN and the SCENE versions of URGENCY and to demonstrate how we can do a better

job of saving lives and preventing disabilities in the hopefully near future. Because the CIREN Centers have multidisciplinary teams investigating crashes, injuries, treatments and outcomes, they are uniquely positioned to identify and promote successful technologies and techniques for improvement of the prevention and treatment of crash injuries.

Research on the continuous improvement of URGENCY software has shown that better recognition of injuries could be obtained if URGENCY 1.0 was modified to take into account the additional crash factors. Of particular interest has been the inclusion of factors to assist in predicting occult injuries.

Occult injuries comprise a very small fraction of all crash injuries, but account for large fraction of the unnecessary deaths. In many cases the deaths might have been prevented had the injuries been recognized and treated in time. Independent studies commissioned by NHTSA found a range of preventable deaths from 17% in rural Montana in a 1992 report [9], 12.9% in a rural Michigan study [10], and 7-21% in North Carolina in a 1995 report [11]. Better prediction of occult and other serious injuries could contribute to earlier recognition of time critical injuries and a reduction of deaths and disabilities from medical errors. [12-30]

Some of the factors, more recently identified by CIREN research, that lead to occult injuries are as follows:

- Certain far side crashes and offset crashes (see Case 1 Illustration)
  - — These crashes may increase abdominal loading by the shoulder belt
- Crashes with rigid narrow objects (see Case 2 Illustration)
  - — These crashes increase safety belt loading and delay air bag deployment
- Frontal crashes with unrestrained rear seat occupants (see Case 3 Illustration)
  - — The driver and right front passenger become vulnerable to injuries from rear seat occupants thrown forward.
- Side crashes with the impact at the front wheels
  - — Post crash spinning and delayed intrusion may contribute to aortic rupture
- Crashes involving multiple impacts
  - — These crashes may introduce complex loading of the chest, abdomen & spine

Research at the WLIRC has proposed the above factors as additional useful indicators of the potential presence of occult injuries. These factors are being incorporated into later versions of URGENCY software as pop-up "Occult Injury Warning Flags" to supplement the serious injury probability ratings of URGENCY version 1.0. The aim of Occult Injury Warning Flags is to create a more robust information tool for point of care emergency medical alerts to prevent tragic misses of occult injuries.

Following is a case summary of a tragically missed liver injury in a far-side crash.

CASE 1 – Occult Liver Injury in Far-Side Crash

Case Vehicle 1997 Lexus

This case involved a 12 year old female who was the left rear-seat occupant in a 1997 Lexus LS 400. The occupant was wearing the available 3-point lap and shoulder restraint. The case vehicle was struck on its right side by a 1997 Toyota Tercel. The point of impact was at the rear right door opposite from the case occupant (see Figure 2.6). The lateral delta V was estimated to be 15 mph and the PDOF was 2 o'clock.

At impact, the occupant moved towards the right side of the vehicle consistent with the 2 o'clock direction of force impact. The left rear occupant contacted and loaded the lap and shoulder restraint with her chest and abdomen. The loading of the chest against the shoulder portion of the restraint resulted in bi-lateral lung contusions at the medial aspect of the lungs. These contusions were at the hilar region of the lung, below the sternum. In addition to the lung contusions, the left rear occupant sustained a heart contusion, which was most prominent over the left ventricle. Both these injuries are below the area that the shoulder restraint crosses when the restraint is used. The loading by the lower portion of the shoulder restraint against the lower right quadrant of the abdomen, resulted in a compression of the abdominal wall as well as the lower portion of the right rib cage. The compression of the lower right rib cage resulted in multiple superficial contusions to the posterior aspect of the left and right lobes of the liver.

Following the impact, the occupant was taken to a local hospital and admitted to the emergency room. She did not meet any trauma criteria based on physiologic criteria and was not triaged to a trauma center based on high suspicion of injury. Although the occupant complained of stomach pains on scene, she remained alert for three hours after the crash. After becoming dizzy in the ER, she was registered to be seen by the pediatrician, her vitals were taken, intravenous access attempted when she went into respiratory arrest. She was then transferred to the trauma room and CPR was initiated. An intra-abdominal hemorrhage was suspected. Her condition deteriorated and at 10:45pm, she

was pronounced dead. This crash occurred at 07:02pm.

Occult liver bleeding was not recognized early enough in this case. Had this relatively minor liver injury been suspected earlier, additional abdominal evaluations would have lead to a discovery of her fatal injury. It should be noted that diagnosis and treatment of this injury could have been made in a non Level I trauma center if necessary. An indication that this injury was likely, based on mechanism, could have altered initial triage decisions and/or focused attention to the abdomen in the emergency room.

Case 2- Occult Liver/Head Injury in Crash with Rigid Narrow Object

Case Vehicle: 1997 Jeep Wrangler

The case vehicle was equipped with 3-point lap and shoulder restraints for all outboard seating positions. In addition the case vehicle was equipped with driver and passenger airbags both of which deployed on impact. The driver and lone occupant of the case vehicle was a restrained 40 year-old female, 64" (163-cm) tall and 135 lbs (61-kg).

The case vehicle was northbound at an estimated speed of 35-mph (56-kph). For unknown reasons (possibly due to a medical condition) the driver lost control and the case vehicle departed the intersection via the northeast corner. The front of the case vehicle impacted a metal traffic signal pole. Direct damage to the case vehicle was 12.6" (32-cm) wide and centered almost perfectly on the frontal plane. This 12 o'clock direction of force impact (CDC: 12FCEW3) crushed the frontal structure of the case vehicle to a maximum depth of 31.9" (81-cm). The crash investigator estimates the deltaV to be 30 -mph (48-kph). Upon impact the restrained driver moved towards the 12 o'clock direction of force as the airbags deployed. The driver's torso contacted and loaded the airbag resulting in anterior and posterior fractures to the left ribs 1-3. The driver's face contacted and loaded the airbag resulting in ecchymosis to the upper right eyelid. The anterior aspect of the driver's left forearm contacted the airbag resulting in a contusion to the forearm. Contact with the restraint system caused a horizontal linear contusion to the driver's lower abdomen and a contusion to the upper left quadrant of her chest. Loading from the shoulder restraint caused a contusion to the right lung and a grade III laceration to the anterior right liver. The driver's right shin sustained abrasions form contact with the knee bolster. The driver's left knee sustained lacerations from contact with the knee bolster. On rebound the driver moved rearward and the left side of her head contacted and loaded the rearmost vertical surface of the window frame. This contact caused swelling to the posterior parietal scalp, a small hemorrhage to the anterior cisterna and a contusion to the anterior temporal lobe.

Case 3- Occult Splenic Injury to Belted Front Passenger Loaded by Unrestrained Rear Seat Occupant

Case Vehicle -1995 Ford Mustang

The case vehicle was a 1995 Ford Mustang equipped with 3-point lap and shoulder restraints for all outboard seating positions. In addition the case vehicle was equipped with driver and passenger airbags both of which deployed. The driver was an unrestrained 22-year-old male. The right front passenger, who was the case subject, was a restrained 22 year-old female, 60" (152-cm) tall and 120 lbs (54-kg). The 2 rear seat occupants were not restrained. The case vehicle was eastbound at an estimated speed of 35-mph (56-kph). The driver lost control due to distractions in the vehicle. The case vehicle departed the roadway to the right and struck a metal light pole. The light pole fractured at its base, and the case vehicle came to rest a short distance from the point of impact. Direct damage to the case vehicle was 14.2" (36-cm) wide and was centered 7"(18-cm) right of the case vehicle's centerline. This 12 o'clock direction of force impact crushed the frontal structure of the case vehicle to a maximum depth of 24.4" (62-cm) located at C4. The delta V for the case vehicle totaled 29.9 mph. Upon impact the restrained right front passenger (case subject) moved towards the 12 o'clock direction of force as the airbags deployed. The unrestrained rear seat occupants impacted the right front seatback, and this increased the case subjects loading of the 3-point restraint (belt). The case subject sustained an abrasion at the base of the anterior right neck as a result of contact with the shoulder restraint. Loading from the shoulder restraint also caused a contusion to the left lung and fracture to the left ribs 7-9 with pneumothorax.

Loading to the left hip from the lap restraint caused a fracture to the case subject's left iliac wing. The case subject was the only occupant admitted to the hospital and she recalls getting out of the car on her own. The crash occurred at 03:42am. The case subject was originally taken to Jackson Memorial Hospital Emergency Room at 04:42am (note: not a trauma center). She was then transferred to Ryder Trauma Resuscitation Unit arriving at 06:22am where an occult splenic laceration was discovered. Following surgery, the occupant was taken to the SICU area at 04:08pm that day for a 9-day recovery period with follow-

up rehabilitation. The outcome of this occupant was good, however, her splenic laceration was undiagnosed for nearly three hours. The delay increased the risk of fatality and may have contributed to lengthening the recovery period.

Summary of Research Findings and recommendations by WLIRC

- The large number of passenger car occupants suffering serious head injuries from side impacts by light trucks suggests that is a frequent mode of severe and fatal injury. The current deformable barrier test devices used in the US and European Side Impact Safety Standards do not induce head impacts during crash tests. Consequently, they do not adequately address this mode of injury. [25, 29]
- The test dummies currently used in the Federal Motor Vehicle Safety Standards do not distinguish the safety belt load concentrations that produce liver injuries observed in the field. The liver injuries suffered by drivers were found to be prevalent in one o'clock crashes. The computer modeled deflection of the lower rib on the dummy was found to predict the liver injuries that were observed in the 1 o'clock crashes. These higher deflections were not present at the center chest location where the chest deflection is currently measured on the Hybrid III. To control safety belt induced injuries, changes in the dummy instrumentation, the chest injury criteria and the crash test condition should be considered in future standards. [27]
- Safety improvements in far side crashes should concentrate on reducing injuries from belt loading in the lower severity crashes. In higher severity crashes the prevention or mitigation of head impact with the opposite side interior should take precedence. Crash testing to evaluate safety features to mitigate contacts with the opposite side interior should be done without a near-side dummy. [28]
- A limited sample of depowered air bag cases showed that a high level of protection continues to exist at high crash severities. However, severe internal chest/abdominal injuries persist in low and moderate speed crashes for unrestrained occupants. [(See Paper in Item 4 below)
- Crashes that involve narrow objects and crashes that involve multiple impacts were found to carry a high risk of injury. Neither of these crash modes is currently simulated by current standards. Future standards should consider safety features to reduce casualty risk in these crash modes. [8]

1. Findings for Improving FMVSS 214 — The Side Impact Safety Standard

"Injuries in Near-Side Collisions" AAAM, 1999 [25] and "Injury Patterns in Near-side Collisions", SP –1518, SAE 2000-01-0634, March 2000 [29] examine injuries and injury mechanisms in side impact crashes being addressed by the United States standard, FMVSS 214. In this side impact protection standard, a moving deformable barrier impacts the occupant compartment of a vehicle being tested. The moving barrier is crabbed at an angle of 23 degrees measured relative to the side of the struck vehicle. The standard assesses the crash protection provided in a vehicle-to-vehicle crash to an occupant seated on the struck side, in the vicinity of the maximum intrusion. The National Automobile Sampling System /Crashworthiness Database System (NASS/CDS) data indicates that 75% AIS 3+ injuries occur in vehicle-to-vehicle crashes, 66% occur to the struck side occupants and 94% occur in crashes with damage to the occupant compartment. Crash directions of 10 and 2 o'clock are the most common injury producing crashes.

The University of Miami School of Medicine -William Lehman Injury Research Center (WLIRC) data was found to be representative of the severe injury crashes in the NASS/CDS database. In the WLIRC data, the most frequent severely injured (AIS 4+) organs were the brain (21%) and the thoracic aorta (21%).

In-depth analysis of brain induced injuries showed that the most frequent injury causing contacts for head injuries were: other vehicle 37.5%; pillar, 25%, and side interior, 25%. Light trucks were most frequently the source of the injuring head strikes. Trucks were the striking vehicles in 48% of the cases, and head contact with a striking truck is the most frequent source of AIS 3+-head injury. In NASS/CDS 1988/96, the striking vehicle was a light or heavy truck in 46% of the cases with AIS 3+ injuries. In the same years of NASS/CDS, trucks constituted about 15% of vehicles in the database.

This large difference in exposure versus involvement suggests that impact from a truck is a strong injury risk factor. The high percentage of serious head injuries from impacts with light trucks in the WLIRC data suggests that is a frequent mode of severe and fatal injury. The current deformable barrier test devices do not induce head impacts during crash tests, and may not adequately address this mode of injury.

For aortic injuries, 100% of WLIRC cases were from contact with the side interior. Other factors that were observed in the WLIRC cases with aortic injuries were: older occupants, oblique angles of impact, and damage to the front fender and door of the struck vehicle. The lower severity crashes with aortic injuries all involved an initial impact in the front 1/3 of the struck vehicle, frequently beginning at the front wheels. The characteristics of these crashes need further study to assess the adequacy of current test procedures in simulating the injury producing crash environment for aortic rupture.

2. Findings for Improving Dummy Design

"Dummy Measurements of Chest Injuries Induced by Two-Point Belt Systems", *44th Annual Proceedings of the Association for the Advancement of Automotive Medicine*, October, 2000 [27]

This paper reported on an observed pattern of severe liver injuries suffered by drivers wearing shoulder belts, without the lap belt fastened. The study found that existing crash dummies were unable to measure the potential for these injuries. Further, the test procedures required by existing safety standards did not simulate the crash condition that produced these injuries.

During the period 1993-1997, 48 cases of drivers protected by shoulder belts but without the lap belt fastened were admitted to the database. Fifty percent of these drivers suffered liver lacerations. Further study showed that the majority of the crashes involved damage to the right front of the vehicle. Among the drivers in vehicles with right front damage, 92% sustained injuries to the liver and the majority were at crash severities lower than 25 mph. This observation indicated that 2-point belts were most likely to produce liver injuries in low severity frontal collisions when the crash direction is 1 to 2 o'clock.

An analysis of the National Accident Sampling System for the years 1988-95 showed that the risk of chest injury is more likely among drivers with automatic shoulder belts than drivers with manual belts. Analysis of NHTSA's crash testing showed that the test dummies required by Federal Motor Vehicle Safety Standards do not distinguish differences between belt systems with and without a lap belt. Consequently, the liver injuries observed in the field were not predicted.

Finite element computer modeling of the currently utilized Hybrid III dummy indicated that the deflection at the right lower rib location was greatly increased when the lap belt was not fastened. The computer models further showed that higher deflections were not present at the central location where the chest deflection is currently measured on the Hybrid III. These results suggested that improvements in test dummy design and instrumentation could offer significant injury assessment benefit.

3. Findings for Improving Occupant Protection in Far Side Crashes

"Injuries to Restrained Occupants in Far-Side Collision", 44th Annual Proceedings of the Association for the Advancement of Automotive Medicine, October 2000. [28]

Occupants exposed to far-side crashes are those seated on the side of the vehicle opposite the struck side. Test procedures required by present safety standards for side crashes require the crash dummies to be located on the side of the vehicle closest to the impact. Far-side occupants, those located on the side opposite the impact, are not included in any test. Studies of injuries in far-side crashes were conducted to assist in identifying safety systems and test procedures to further improve occupant safety.

This study used the NASS/CDS 1988-98 to determine distributions of AIS 3+ injuries among occupants exposed to far-side crashes and the sources of the injuries. The William Lehman Injury Research Center (WLIRC) data from 1994-98 was used to assess injury mechanisms among seriously injured crash exposed far-side occupants.

The NASS/CDS indicated that injury patterns for far-side restrained drivers were different from far-side restrained front passengers. For the driver, the head accounted for 40% of the AIS 3+ injuries in far-side collisions and the chest/abdomen accounted for 45.5%. For the right front passengers, head injuries contributed 27.2%, while chest and abdominal injuries accounted for 64.5%. The opposite-side interior was the most frequent contact associated with driver AIS 3+ injuries (30.5%). The seat belt was second, accounting for 22.6%. Among thirteen WLIRC cases of far-side belted occupants with MAIS 3+ injuries, five of the most serious injuries were attributed to the seat belt. The liver or the spleen was the most seriously injured body organ in all five cases.

The presence of an occupant on the near-side changes the injury pattern of the far-side occupant, mitigating injuries from contacts with the opposite side interior. Crash testing to evaluate safety features to mitigate contacts with the opposite side interior should be done without a near-side dummy. Safety improvements in far side crashes should concentrate on reducing injuries from belt loading in the lower severity crashes. In higher severity crashes the prevention or mitigation of head impact with the opposite side interior should take precedence.

4. Findings on the Field Performance of Depowered Air Bags

"Performance of Depowered Air Bags in Real World Crashes", SAE 2002 01-0188, March 2002.

The paper compared the crash characteristics for injured occupants in vehicles with 1st generation and depowered air bags. In the limited number of depowered cases investigated by the William Lehman Injury Research Center, the performance of depowered air bags has been very good. High speed protection in very severe crashes has been observed for both restrained and unrestrained occupants. The database of depowered air bags contains no significant injuries in very low speed crashes, and no injuries to children. However, serious internal chest injuries were observed in two cases with unrestrained drivers at low crash severities. One of these crashes produced in a fatal heart injury and the other an AIS 5 liver injury. These cases contained the only unexpected injuries among the population protected by depowered air bags.

During the period 1992 through 2000, the William Lehman Injury Research Center collected crash and injury data on 141 drivers and 41 right front passengers in frontal crashes with air bag deployment. Among these cases were twenty-eight cases with depowered air bags.

The population with 1st generation air bags contained unexpected fatalities at low delta-V's. To date, these populations are absent among the fatally injured occupants of vehicles with depowered air bags. The depowered cases include both belted and unbelted survivors at crash severities above 40 mph delta-V. The maximum injury in these severe crashes was AIS 3 with no evidence of unsatisfactory air bag performance. However, serious internal chest injuries were observed in two cases with unrestrained drivers at crash severities of 19 and 24 mph.

This limited sample of depowered air bag cases indicates that a high level of protection continues to exist at high crash severities. However, severe internal chest/abdominal injuries persist in low and moderate speed crashes for unrestrained occupants.

5. Improvements in Crash Injury Identification and Treatment

"Development and Validation of the Urgency Algorithm to Predict Compelling Injuries", Paper Number 350, ESV Conference, June 2001 [8]

The development of methods for improving the identification and treatment of crash injuries has been a major priority for WLIRC. In 1994 WLRIC proposed the SCENE Scale to assist first care providers in identifying crash victims with occult injuries. This effort has continued and expanded to the development of the URGENCY Algorithm. The URGENCY algorithm uses data from onboard crash recorders to assist in identifying crashes that are most likely to have time critical (compelling) injuries. The injury risks projected by using the NASS/CDS data are the basis for the URGENCY algorithm. [31]

This study applied the algorithm retrospectively to a population of injured occupants in the database from the University of Miami School of Medicine, William Lehman Injury Research Center (WLIRC). The population selected was adult occupants in frontal crashes that were protected by three point belts plus an air bag.

The conclusions are applicable to the URGENCY algorithm applied to all William Lehman Injury Research Center cases of frontal crashes with occupants protected by belts and air bags. This research with WLIRC cases found confirmation that URGENCY can differentiate crashes with serious injuries from non-serious injury crashes, but that improvement in the algorithm is both necessary and possible.

For the cases with greater than 50% predicted MAIS 3+ injury probability, 96% had MAIS 3+ injuries. Specific improvements introduced were risk factors associated with multiple impact crashes, pole crashes and air bag deployment injuries.

Overall, the predictive capability of the URGENCY algorithm was considered to be satisfactory for use as an aid in identifying occult injuries among occupants that do not meet physiological triage criteria at the crash scene.

"Validation of the URGENCY Algorithm for Near Side Crashes, *46th Annual Proceedings of the Association for the Advancement of Automotive Medicine*, p. 305-314, October, 2002.

The URGENCY algorithm was validated for near-side crashes by applying it retrospectively to the population of injured occupants in NASS 1997-2000. The use of an injury probability of greater than 50% gave reasonable predictions of MAIS 3+ injuries in near-side crashes.

Knowledge of vehicle side intrusion was found to be beneficial in reducing the false negatives, but with an increase in false positives. Treating intrusion as a continuous variable reduced the number of false negatives at the expense of increases in false positives.

Overall, the URGENCY algorithm predicted about 67% of the occupants with MAIS 3+ injuries and about 94% without MAIS 3+ injuries. The use of intrusion as a continuous variable increased the percent of MAIS 3+ injuries predicted to 80.7%.

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